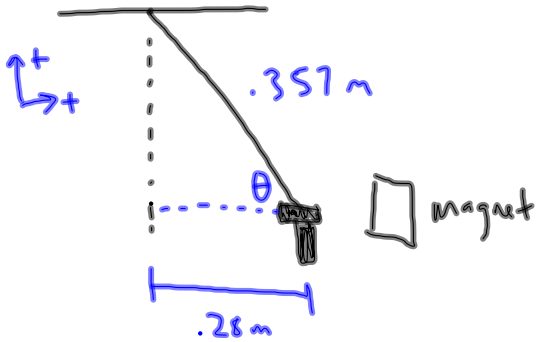
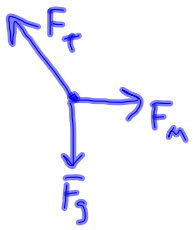
Semester Exam Review AP Physics 1.4.12

An iron bolt of mass 65.0 g hangs from a string 35.7 cm long. The top end of the string is fixed. Without touching it, a magnet attracts the bolt so that it remains stationary, displaced horizontally 28.0 cm to the right from the previously vertical line of the string.
a) Draw a free-body diagram of the bolt.
b) Find the tension in the string.
c) Find the magnetic force on the bolt.



A)



$$\theta = \cos^{-1}\left(\frac{.28\,m}{.357\,m}\right) = 38.3^\circ$$

b) $\Sigma F_y = \emptyset$

$$F_{TY} - F_g = \emptyset$$

$$F_{TY} = mg$$

$$= 0.637\,N$$

$$\sin\theta = \frac{F_{TY}}{F_T}$$

$$F_T = \frac{F_{TY}}{\sin\theta}$$

$$= 1.03\,N$$

c) $\Sigma F_x = \emptyset$

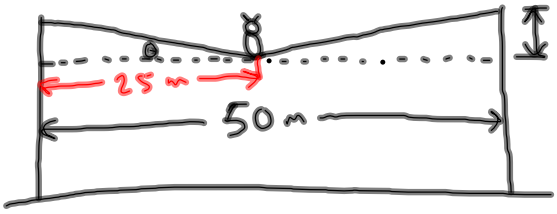
$$F_m - F_{Tx} = \emptyset$$

$$F_m = F_{Tx} \qquad F_{Tx} = F_T \cos\theta$$

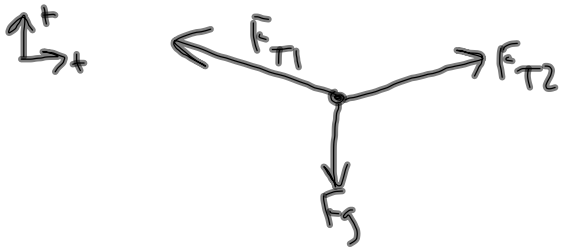
$$= 0.805\,N$$

The distance between two telephone poles is 50.0 m. When a 1.00 kg bird lands on the telephone wire midway between the poles, the wire sags 0.200 m. Draw a free-body diagram of the bird. How much tension does the bird produce in the wire? Ignore the weight of the wire.

*Absurdly NOT to scale



$\theta = \tan^{-1}\left(\frac{.2\text{ m}}{50\text{ m}}\right) = .458^\circ$



$\Sigma F_y = \emptyset$

$F_{T1y} + F_{T2y} - F_g = \emptyset$

$F_{T1y} + F_{T2y} = F_g$ $\qquad$ $F_{T1y} = F_{T2y} = F_{Ty}$

$2F_{Ty} = F_g$

$F_{Ty} = \frac{mg}{2}$

$= 4.9\text{ N}$

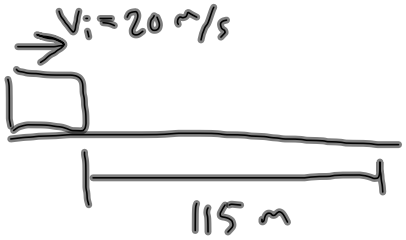
$F_T = \frac{F_{Ty}}{\sin\theta}$

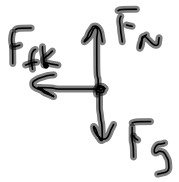
$= 613\text{ N}$

for one side of wire

Total $F_T = 1226\text{ N}$

A hockey puck on a frozen pond is given an initial speed of 20.0 m/s. If the puck always remains on the ice and slides 115 m before coming to rest, determine the coefficient of kinetic friction between the puck and ice.





$$\sum F_x = ma_x \qquad \sum F_y = 0$$

$$F_{fk} = ma_x \qquad F_N - F_g = 0$$

$$F_N = mg$$

$$\mu_k = \frac{F_{fk}}{F_N}$$

$$= \frac{ma_x}{mg}$$

$$= \frac{a_x}{g}$$

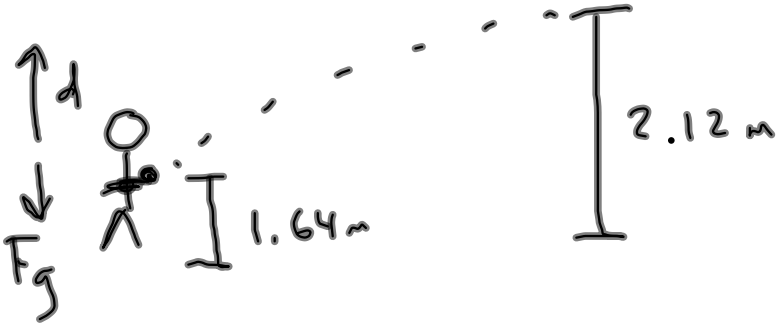
$$= \frac{-v_{ix}^2}{2\Delta x g}$$

$$= 0.177$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \quad (v_{fx} = 0)$$

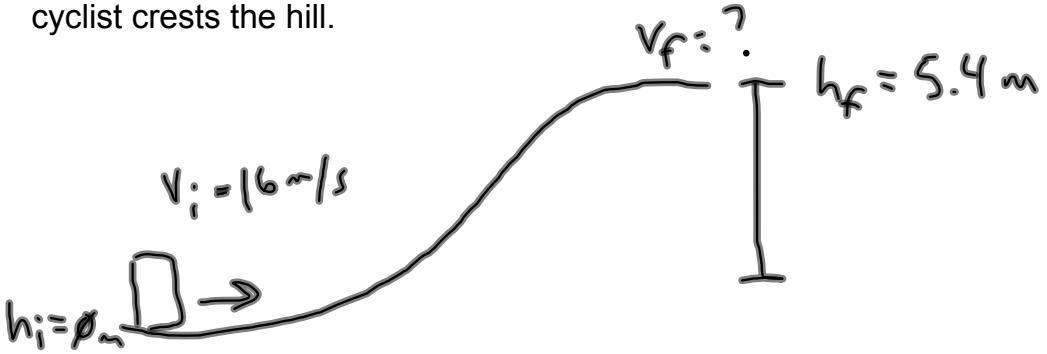
$$a_x = \frac{-v_{ix}^2}{2\Delta x}$$

A shot-putter puts a shot (weight = 71.6 N) that leaves his hand at a distance of 1.64 m above the ground. Find the work done by the gravitational force when the shot has risen to a height of 2.12 m above the ground.



$$W = F_g \cdot d$$
$$= F_g d \cos\theta$$
$$= F_g d \cos(180^\circ)$$
$$= -34.4\ N$$

A cyclist approaches the bottom of a gradual hill at a velocity of 16 m/s. The hill is 5.4 m high, and the cyclist estimates that she is going fast enough to coast up and over it without peddling. Ignoring air resistance and friction, find the velocity at which the cyclist crests the hill.



$$E_i = E_f$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$v_f = \sqrt{v_i^2 + 2g(h_i - h_f)}$$

$$= 12.3\ m/s$$

A pitcher throws a 0.14 kg baseball, and it approaches the bat at a speed of 45 m/s. The bat does 70 J of non-conservative work on the ball as they are in contact. Ignoring air resistance, determine the velocity of the ball after the ball leaves the bat and is 25 m above the point of impact.

$W = \Delta E$ choose $h_i = 0$ m

$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$ (mgh_i → 0)

$v_f = \sqrt{\frac{2}{m}\left[W + \frac{1}{2}mv_i^2 - mgh_f\right]}$

$= 50.3$ m/s